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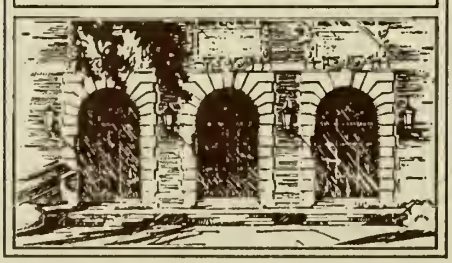

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REPORT NO. 138

THREE NEW MERSENNE PRIMES, AND A CONJECTURE

by

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If p is prime, $M_p = 2^p - 1$ is called a Mersenne number.

If $u_1 = 4$ and $u_{i+1} = u_i^2 - 2$, then M_p is prime if and only if $u_{p-1} \equiv 0 \pmod{M_p}$. This is called the Lucas test (see Lehmer [3]).

The primes M_{9689}, M_{9941}, and M_{11213} which are now the largest known primes, were discovered by Illiac II at the Digital Computer Laboratory of the University of Illinois. The computing times were 1 hour, 23 minutes, 1 hour, 30 minutes, and 2 hours, 15 minutes respectively, and the calculations were checked by repetition. This brings to 23 the number of known Mersenne primes, namely for

p = 2,3,5,7,13,17,19,31,61,89,107,127,521,607,1279,2203,2281,3217,4253,4423,9689, 9941, 11213.

The numerical values of M_{9689}, M_{9941}, and M_{11213} are shown in Table IV.

The Lucas test was applied to all M_p, $p \leq 12{,}143$ for which no factor is known and the residue u_{p-1} was printed in modified octal (one base 4 digit and 14 octal digits per word). The last five octal digits of these residues are shown in Table V for all $p \leq 12{,}143$. As an indication of the speed of Illiac II, the residue for M_{8191} took 100 hours on Illiac I (D. J. Wheeler), 5.2 hours on an IBM 7090 (Hurwitz [1]) and 49 minutes on Illiac II. The three values agree.

An Illiac II word has a 45-bit mantissa and a 7-bit exponent. The program checks the multiple precision arithmetic modulo $2^{44} - 1$. Four errors were found in the residues given in Hurwitz [1], namely

3637	53313	not	67413
3847	14400	not	57652
4397	44327	not	40174
4421	03013	not	25131

and ten errors were found in the results of M. Berg and S. Kravitz, privately communicated, for the range $6000 < p < 7000$. In no case has the Illiac II program obtained different results on different runs.

The author is indebted to J. Brillhart for a list of prime factors $< 2^{34}$ of Mersenne numbers. For the range $5000 < p < 17000$ a wider range factor table was computed by Illiac II and Table VI gives these factors. These were used to exclude some values M_p from the Lucas Test.

The very large gap in p, 4423 to 9689, between successive Mersenne primes raises the question of what is the distribution of Mersenne primes and of factors of Mersenne composites. I. J. Good [6] suggested that the number of prime $M_p < x$ is asymptotic to 2.3 log log x, and D. Shanks [7] in effect suggests approximately $\frac{5}{\log 10}$ log log x. It will be suggested in what follows that $\frac{2}{\log 2}$ log log x is the correct asymptotic function. Since the number of Mersenne primes is a slowly varying function of x, a stronger assumption will be made, which implies the above and can be tested by studying the distribution of prime factors of Mersenne composites.

It has been proved by Fermat and Euler that all factors of M_p must be of the form $2kp + 1$ and simultaneously of the form $8\ell \pm 1$. This means that, depending on p, k is constrained to one of the sequences

$$1, 4, 5, 9, 12, \ldots \text{ and } 3, 4, 7, 8, 11, 12, \ldots$$

Thus the smallest potential factor is either $2p + 1$ or $6p + 1$ and thereafter potential factors are spaced an average of $4p$ apart. In the conjecture that follows, we suggest that statistically, this theorem sets a lower bound on potential divisors, but does not change the expected probability density of divisors above that lower bound--the low density of potential divisors is just compensated for by a high conditional probability that any one of these actually divides M_p.

The prime number theorem implies that a randomly chosen integer in the range s to $s + \Delta s$ is prime with probability $\sim \frac{1}{\log s}$, as $s, \Delta s \to \infty$ but $\frac{\Delta s}{s} \to 0$, and that the probability that such a number is prime and also divides some large random number N is $\frac{1}{s \log s}$. The probability that there is

no factor of N in the range $A \leq s \leq B \leq \sqrt{N}$ is given asymptotically by

$$e^{-\int_A^B \frac{ds}{s \log s}} = \frac{\log A}{\log B} .$$

CONJECTURE. If $A \leq B \leq \sqrt{M_p}$ then the probability that there is no divisor s of M_p in the interval [A,B] is given asymptotically by

$$\frac{\log A}{\log B} \quad \text{if} \quad A \geq 2p$$

or by

$$\frac{\log 2p}{\log B} \quad \text{if} \quad A < 2p ,$$

and prime divisors are statistically independent. Thus Mersenne numbers are asserted to have the same likelihood of being prime, and to have the same statistical distribution of factors as integers of about the same size which are selected to have no factors less than 2p but are otherwise randomly chosen.

If true, this conjecture implies

(1) The probability that M_p is prime is $\frac{2 \log 2p}{p \log 2}$

(2) The expected number of primes in any interval [x, 2x] in p is $2+2\log\left(\frac{\log 2x}{\log x}\right)$ which is asymptotically equal to 2.

(3) The number of prime factors less than $B \leq \sqrt{M_p}$ is Poisson distributed with

$$\text{mean} = \log\left(\frac{\log B}{\log 2p}\right) .$$

The observed frequency of Mersenne primes in the interval [x, 2x] in p is shown in Table I:

x	5	10	20	40	80	160	320	640	1280	2560	5120
Number of primes in [x, 2x]	2	3	1	1	3	0	2	1	2	3	2

The total number of prime factors less than 2^{36} of Mersenne numbers in the interval $5000 < p < 7000$ was estimated as $\left[\pi(7000) - \pi(5000)\right] \log\left(\frac{\log 2^{36}}{\log 12000}\right)$, and was also counted using the factor table prepared. Similar calculations were done for other intervals of length 2000 in p and the results are shown in Table II:

Range of p	5000 to 7000	7000 to 9000	9000 to 11000	11000 to 13000	13000 to 15000	15000 to 17000
Factors $< 2^{36}$ observed	223	209	206	192	175	169
Predicted number	226	205	206	192	184	181

This agreement appears very good, with perhaps a tendency toward fewer than the expected number of factors for large values of p.

Finally a check was made on the independence of factors found, namely whether the number found per value of p follows a Poisson distribution. The exact distribution of the aggregate sample would be a sum of Poisson distributions corresponding to each value of p but since the mean varies only 15% over the range, a comparison is made with the Poisson distribution obtained from the observed aggregate mean, in Table III:

Number of prime factors $< 2^{36}$	0	1	2	3	4	5
Observed p with that frequency	513	495	199	76	12	1
Predicted number	525	474	215	65	15	2.6

1. A. Hurwitz, "New Mersenne Primes," Math. Comp., v. 16, 1962, pp. 249-251.

2. S. Kravitz, "Divisors of Mersenne Numbers $10,000 < p < 15,000$," Math. Comp., v. 15, 1961, pp. 292-293.

3. D. H. Lehmer, "An Extended Theory of Lucas' Functions," Ann. of Math., v. 31, 1930, pp. 419-448.

4. H. Riesel, "Mersenne Numbers," MTAC., v. 12, 1958, pp. 207-213.

5. H. Riesel, "All Factors $q < 10^8$ in all Mersenne Numbers $2^p - 1$, p prime $< 10^4$," Math. Comp., v. 16, 1962, pp. 478-482.

6. I. J. Good, "Conjectures Concerning Mersenne Numbers," MTAC., v. 9, 1955, pp.120, 121.

7. D. Shanks, Solved and Unsolved Problems in Number Theory, Spartan Books, Washington, 1962, p. 198

4782202 7880546120 2952839298 6600059097
4149717240 2236500851 3345109918 3789509426 6297027892 7686112707
8945868247 2098152425 6319306585 0526768340 8748083442 9433264797
4258932476 2368833102 1633208954 8473548057 9994334130 9825989013
7438061871 0958104314 8680813778 3215304967 1560156328 2624414040
3981432076 2203627219 0408590790 5372034752 5610556407 1579263867
8752409855 7335652265 6108542128 5773210578 7905232886 5035355873
6156793636 5588992571 1574420153 8320917524 2284304691 8811427400
6621355593 0351685370 3976812686 3857503762 2778794958 0582081831
2617257010 0349820651 2329872677 2334895109 5346937568 3037038373
9996967715 8578890563 9115522613 4054957071 8452415821 9208223766
4420590145 9333065700 9722153962 3768534237 7048613857 8089775621
3011678112 9916640736 1746606697 8081867579 6691467124 6073712904
2005884089 2318638773 7887675292 8869537970 6698096740 6053530122
8535390369 6549022478 4924649007 9548986785 0331465554 6475504501
6861873548 6696437455 2614120640 7829496224 5202778896 2138602665
9331476876 9632208950 4278791624 6515193123 2783175655 3779377194
5246733958 1928148666 8576384019 5907201794 1334958297 0319393884
3888104945 4604034208 7536563628 3321520731 8161430072 1769371426
2385175405 2084521466 5313301183 5519625918 4955893849 9025348780
3767164770 7393063443 6840084468 2559374434 5169031599 9349137664
6389689726 1419901530 4906547819 0562271712 2494707073 9716300953
7757434413 0792050186 3532234466 5456456957 7433188504 4978250148
6634673721 3039209989 4852145190 9982328787 7248665051 3010816769
9028925187 1925006694 7215706536 2162486962 4056925686 5554296221
5522115604 2777866254 5936998801 0701861626 0147647429 3459830183
6512733634 6273267588 3060701410 3592548291 4977433929 7173680765
6109595999 1130918978 8238350131 6356726614 3596921823 9977196933
8743954039 9662367558 0528211207 1363963708 5805605116 0781770985
4525769880 3233381293 9272752101 9446295274 9031383555 1985197095
9288852364 1530178921 8675141014 5412030961 9127093436 9039522098
2803176689 4206132557 2349643638 4030564873 4929088422 3786292887
4722312190 3238528103 4091824306 6189477407 2726552428 4893304474
8614549420 7679904173 9447165838 2816714104 3583120679 0501914527
3262873703 3997470720 6016882562 8274042701 7032260672 7980343479
3264257300 9183981307 7719322455 3947639606 0658821432 6603156141
4907405576 9805516626 3044447583 7567115164 9018119344 2236859424
1518437953 8933576543 2129944054 8553451558 5927342456 1825146813
7147206062 8778102124 0923708021 4922983496 3517952727 0302962970
1569276865 1163505008 0407282674 2523626446 9571076976 8866137302
7893136096 7438271901 7385508484 6633734761 2084356798 3065059558
0729351106 3754424080 7350667082 9872337797 6887493898 3584523095
6389961206 1631863439 1967112086 4643846494 7096323007 2729200912
5861472679 9976249670 9852769503 5357339244 1620265772 0741248683
5922028289 8331114083 3923302433 9177979769 9031142584 3619350936
7544838111 9440881276 3388084204 4518049124 5438388418 0800945275
6266680576 2895476338 4641305107 7537732470 8249580453 3355717481
9650250708 1973046642 2826105697 5105642897 9895118219 2885976352
2290538989 4873761464 2139910911 5358645058 1899269682 6225754111

Table IV: M_{9689} in decimal

346 0882824908 5121524296 0395767413 3167226286 6890023854
7790489283 4450062208 0983411446 4364375544 1537075336 6448674763
5050186414 7070933237 3970608376 6904042292 6578964799 3709760358
4695523190 4548491005 0304149809 8185402835 0715968356 2232941968
0597622813 3454473972 0849260904 8551927706 2605491179 3590389060
7959811638 3872143299 4278763633 0953774381 9484486647 1124967685
7988881722 1203300082 1469684464 9561469971 9412692128 4336206463
3138595375 7720046244 2029064681 3260875582 5748847048 9384243989
2702368849 7864306309 3004422939 6033700105 4659538630 2009073043
9444822025 5909740670 0597330570 7995078329 6313093873 9885080198
4162586351 9452291304 2562936679 8595874957 2103117374 7796418895
0607019417 1750600193 7152430032 3636319342 6579851623 6047451209
0898647074 3078036229 8307038193 4454864937 5664799180 4258775574
9738339033 1573508289 1029392359 3527586171 8501994255 4834671861
0745487724 3988072960 6244911940 0666801128 2382409581 6458261761
8617466040 3480205646 6823143718 2554927847 7938099174 9580255263
3233265364 5774389415 0848953969 9028185300 5787087622 9329803338
2857354192 2825902216 9602665532 2108347896 0205168654 6011466737
9813060562 4748005507 1718250333 7375022673 0734417851 2950738594
3306843408 0269822896 3986562732 5971753720 8729564907 2830289749
7713583308 6795150871 0859216743 2185229188 1167063744 8496498549
0944305412 7744407940 7989539857 4694527721 3216658088 5754360477
4088429133 2729294869 6897496141 6149197398 4543283589 4324473601
3876096437 5051469921 5032683744 5270717186 8409183217 0948369396
2800611845 9374614358 9068811190 2531018735 9531915610 7319196071
1505984880 7002708870 5842749605 2030631941 9116692210 6176157609
3672419481 6062598903 2127984748 0810753243 8263209391 3796444665
7006013912 7836032300 2267434295 1943256072 8066126011 9378719405
1514975551 8754925213 4264394645 9638539649 1330969777 6533329401
8221580031 8288927807 2368602128 9827103066 1811511896 4131893657
8454002968 6001242039 1376964670 1839835949 5411248456 5597312460
7377987770 9207170671 0824503707 4572201550 1589959176 6244957768
0068024829 7667392039 2995410164 2247764456 7122214980 3657927708
4129255555 4281704557 2430846389 9881299605 1922731398 7291200902
0608820607 3376207589 2299473666 4058974270 3581178687 9875694315
0786544200 5560346962 5309399653 9559323104 6643003914 6465805452
9650140400 1942389755 2675534768 2486246319 5143149318 8170905972
5887801118 5028119055 9073677771 1874328140 8867867428 6302108275
1492584771 0129645183 3651979717 3751709005 0567364596 4696355331
3698192960 0026738958 3289299126 7383457269 8032599895 5997501176
6642010428 8854608569 9446442834 1952329487 8748841059 5750197438
7863531192 0421085580 4692460582 5338329677 7194691145 9901921324
9849688100 2118996828 4941331573 1640563047 2548086892 1823442538
1995903838 5241278684 0833479611 4199701017 9297835565 3650755329
1382986542 4622534682 7207503606 7407459569 5812738374 8717825918
5274731649 7058209518 1312905519 2427102805 7302314555 4793628499
0105092960 5584971237 7978984921 8399970374 1589767415 4830708629
1454847245 3672457262 2450131479 9926816843 1046444943 9022250504
8592508347 6189478888 9552527898 4009881962 0001486857 5640233136
5091456281 2719135485 8275083907 8914699790 1942622488 3789463551

Table IV: M_{9941} in decimal

281411 2013697373
1333931529 7584258419 1818662382 0136007878 9241934934 5515176682
2763138107 1509474563 3257074198 7893085350 7153734244 5016418881
8017893905 4870941439 1857257571 5657587064 7841835674 7070674633
4971880530 5087541682 1624325680 5558260711 1069194660 7460873056
9653608305 7159024277 4934226866 1839663091 8543346251 4537484258
6559823862 3504602922 7507801410 9071633484 3954778109 3397260096
9096770918 4394455575 4221115477 3437602069 7965006708 7884993478
0129772778 7853280743 2236554020 9315718023 1042992316 7588432457
0361041108 5096043976 9038450365 5140223496 2538366575 1207169661
6973527322 3611192684 6454751701 7345270113 7914817510 7820821297
6289467956 3109896076 7492250494 8342540733 3441412162 7833939461
5392125289 3201072613 6689293688 8156654916 7139517471 0452663709
1757536037 7415685576 6515313827 6137272816 9669263352 9666363787
2865397699 4160910777 7183593336 0026801245 1763345149 0439598324
8238364572 5121940639 1432635639 2256045560 4239600430 7799361927
3799005864 0042076309 2320813392 2624929420 7631293326 8033818471
5552558206 3930888994 8665570202 4038158563 1357894977 9767046261
8453279567 2576728920 5262311752 0147862478 1333183401 5084475386
7605266122 1734057972 1237414485 8037253554 6302200953 6301008145
8675247046 0461886203 9093555206 1953282409 5189510704 0793284825
0954625301 5187282399 7171764140 6633158043 0900861194 2578380931
0647489915 9440747632 8437785848 8254239211 7061493829 4029483257
1629792993 8894069587 7375448948 0811083452 9339432780 8452729789
8341351401 9391241966 1799488795 2103282381 1274221870 0634541149
7436572872 3284342636 9348804878 9934719624 0339396785 7676150371
6001966502 5216825011 7793178488 0120005054 2282136255 0520509209
7244598958 5236682747 7851619190 5032548531 1502940313 2178989005
1957511943 0134027728 2730390683 6511205878 9506019875 3121882187
7886570240 0729178418 6518589977 7885103067 4394589610 8645258766
4156928256 6417447061 6153305144 8522738845 4963505925 5410606458
4273238641 0950668763 6314447514 2690949329 5321992421 2594695157
6550091585 2117342092 3275882063 3276254086 1796303296 2033572563
5536040560 9783211154 7535908988 4338169197 4761581716 1606620557
3070003771 9473001343 1815560750 1590278421 6490142254 4571224546
9367932349 7089495466 8425436412 3477853761 9431003013 9080568383
4207726286 1872264610 9707506566 9281028000 3396170434 3991962002
0597945655 2777491388 3237756792 7200655437 6864079217 7441559278
2723508230 9284368353 4396679150 2296761018 3424378782 0420087274
0286172126 8457638873 3605769491 2241098665 9257736066 6241467280
1589886055 2348634588 0882227855 5057063092 7634941503 4547677180
6182963528 6626300550 9222254318 4597681941 2672760304 7460344175
5810292983 2017122635 5234439676 8163099191 2757420633 4807719021
8754138915 8087152904 9187829308 4121334009 1041975631 3021540478
4366041784 4675773899 8632083586 2079922340 8516263437 5406771169
7073232139 8828494377 9122171985 9536058979 0229178176 8286548287
8781804150 6063546004 7164104095 4837772017 3746887332 4068550430
6958262103 0431633638 5311384093 4900213323 7246346337 3977427405
8966738275 4420312857 4874581960 3352320056 3722931959 2369288171
3752767022 6045091173 5069504025 0166677552 1493207364 3654199488
4770103639 0937200575 7899989580 7757751266 2111305790 5717449417
2220160705 3024391611 6705990451 3042562063 1828929773 8303095152
4305497722 3951496482 1601838628 8614463019 3601771054 6777503109
2630309947 4739761857 6207373447 7254414271 3536242836 0863669327
1576359830 4544797181 6718801639 8695475251 4630565557 1843717916
8756691403 2072497856 8586718527 5866024396 0233528351 3944980064
3270302781 0422414497 1883680541 6897847962 6739147608 7696392191

Table IV: M_{11213} in decimal

Table V: Lucas Residues for $p < 11{,}400$

P residue	P residue	P residue
2 -	313 02246	647 74350
3 -	331 77175	653 61575
5 -	347 76076	661 50426
7 -	349 67177	673 24350
13 -	373 67521	677 04110
17 -	379 32311	691 46704
19 -	389 14135	709 26643
31 -	401 20721	727 60377
61 -	409 45336	733 77214
89 -	421 74216	739 55065
101 72066	433 45210	751 43611
103 55476	439 06636	769 26011
107 -	457 05600	787 17045
127 -	467 22017	797 55244
137 77550	479 26225	809 56736
139 53004	503 77275	821 56017
149 04577	509 10315	823 11022
193 06362	521 -	853 46414
199 67307	523 67657	887 36277
227 63716	541 25253	919 62325
241 62747	563 75077	947 71416
257 35250	569 57547	971 71262
269 41506	599 55245	983 07153
271 67351	607 -	991 54514
293 74572	613 25474	997 26343
307 40635	631 57303	1061 50556

P residue	P residue	P residue
1063 33064	1487 70562	1933 67541
1069 26061	1493 03173	1949 76457
1087 26637	1549 52273	1951 47123
1109 67204	1553 07421	2027 74437
1123 22707	1567 02570	2029 31211
1151 47342	1571 64574	2053 35065
1163 47576	1579 36064	2087 34206
1171 02010	1597 44266	2089 44263
1217 76613	1601 42154	2129 13006
1237 55742	1613 12030	2137 76527
1259 56251	1619 62340	2143 22504
1277 74272	1621 20507	2153 26730
1279 -	1657 57656	2161 00314
1283 75032	1669 37217	2203 -
1289 65347	1699 42750	2221 74014
1291 61137	1733 62344	2237 76774
1297 22725	1747 57322	2239 67122
1301 40241	1753 66055	2243 40670
1307 03053	1759 22017	2267 73073
1319 31014	1783 15265	2269 45440
1373 56733	1787 02767	2273 21661
1409 17120	1831 54121	2281 -
1427 65142	1867 51104	2287 15072
1429 15715	1873 77122	2293 13215
1471 43741	1889 42676	2311 15173
1483 52161	1907 73435	2341 07415

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P residue	P residue	P residue
2347 32152	2789 76456	3251 16002
2357 73755	2791 54413	3259 44224
2371 65041	2797 36762	3271 52222
2377 01201	2801 26322	3301 72013
2381 21005	2803 77752	3307 62061
2383 42577	2833 00365	3313 10050
2423 40520	2851 63335	3331 51270
2437 44263	2861 26370	3343 76415
2441 63033	2879 04010	3371 57040
2467 50433	2887 55047	3373 36120
2473 25401	2927 50235	3389 64705
2477 46576	2957 72234	3407 47335
2503 23011	2969 26336	3413 50261
2521 54751	2971 53516	3449 26453
2551 06004	3019 23616	3461 03241
2557 32321	3049 73343	3463 57665
2633 17651	3061 32511	3467 23046
2647 17616	3079 76331	3469 21765
2659 52257	3089 66237	3547 75574
2671 07552	3109 33761	3559 45350
2683 73666	3169 32333	3583 42507
2693 77061	3187 42211	3607 45062
2713 61363	3203 40242	3613 16120
2719 16103	3209 37347	3617 35431
2729 56435	3217 -	3631 14530
2777 74644	3229 64405	3637 53313

P residue	P residue	P residue
3643 04606	4093 26670	4481 70216
3671 04031	4111 20437	4493 36053
3673 01626	4133 66046	4519 01571
3677 32350	4157 43640	4523 22235
3691 54715	4159 62544	4547 62126
3697 53743	4177 16076	4567 74267
3709 06427	4201 53211	4583 46556
3727 75371	4219 51756	4591 47243
3739 22413	4231 51457	4621 74601
3769 00747	4241 11012	4637 65312
3821 52075	4253 -	4643 51444
3833 45453	4259 46007	4651 00707
3847 14400	4261 55632	4663 52442
3877 46507	4283 74774	4673 40333
3881 34503	4327 75542	4679 14305
3889 30737	4337 37311	4703 54013
3919 16520	4339 41356	4721 04420
3929 63331	4349 74465	4729 40137
3943 33442	4357 74271	4733 12774
3947 46201	4363 61114	4751 77401
4007 17770	4397 44327	4783 77350
4027 60265	4409 51070	4789 02364
4049 31260	4421 03013	4799 04305
4051 63236	4423 -	4817 70020
4079 17563	4451 06734	4831 33213
4091 55650	4463 17523	4877 75412

P residue	P residue	P residue
4889 24410	5647 40775	6133 42630
4909 61113	5653 50244	6151 63451
4937 26525	5669 57031	6211 71252
4951 22271	5689 32731	6217 07377
4969 20732	5693 47014	6221 24166
4973 03354	5701 33577	6229 06517
4987 72275	5737 07151	6247 00472
5023 35472	5749 47641	6257 36710
5077 27063	5783 15446	6269 57356
5081 74607	5813 25753	6299 71037
5099 67662	5839 24031	6329 25136
5113 20010	5851 37460	6337 21676
5153 52273	5857 11252	6359 51351
5309 40357	5869 00764	6361 10027
5333 44244	5879 52670	6451 23476
5351 05171	5897 30763	6469 51252
5407 51133	5923 16616	6547 06546
5419 70701	5953 32461	6571 67142
5443 51737	6007 07707	6577 45051
5471 52563	6037 21420	6581 74210
5477 33022	6043 21605	6599 77554
5479 17227	6047 37000	6659 75241
5503 26142	6053 53471	6679 13275
5527 41614	6073 41646	6701 07636
5573 34740	6079 15712	6709 05700
5581 31446	6091 02043	6733 35544

p	residue	p	residue	p	residue
6763	01753	7481	56621	8147	32143
6791	41143	7489	31253	8191	03624
6823	14573	7507	62414	8233	75260
6833	26431	7523	54030	8263	73755
6857	63102	7559	01556	8291	31062
6911	63345	7577	74000	8297	63521
6971	65345	7603	42610	8311	72342
6991	50365	7607	04024	8329	64615
7069	07313	7621	43263	8363	55516
7109	76754	7649	17277	8369	76051
7121	11254	7699	15637	8389	21672
7127	70746	7703	11617	8443	14744
7177	64624	7723	56523	8447	05235
7213	35572	7727	65716	8521	47055
7229	21270	7753	00553	8527	06705
7237	44431	7757	35327	8543	63267
7243	75126	7793	01165	8581	17603
7247	21344	7817	00650	8609	52627
7309	16030	7867	12212	8647	12277
7321	03466	7927	35532	8681	35061
7331	55736	7937	36343	8707	37065
7333	40632	7949	55402	8753	32153
7351	43525	8009	55062	8819	24665
7369	60027	8069	61334	8831	51436
7433	13456	8089	24237	8837	25460
7477	34613	8117	07547		

p residue	p residue	p residue
8861 22326	9463 63616	9931 25643
8863 03214	9473 02247	9941 -
8887 23230	9533 43134	9967 56346
8893 47223	9551 33274	10037 34070
8923 41014	9587 05303	10061 30610
8941 01034	9623 26262	10069 23577
8999 36025	9631 02445	10079 70743
9011 74242	9649 10710	10099 11311
9013 56660	9661 27003	10159 47661
9041 56532	9679 75063	10169 37134
9091 53605	9689 -	10177 75465
9133 17234	9697 24211	10259 72321
9151 36255	9719 32015	10273 50763
9187 75427	9721 13527	10303 21613
9203 23113	9749 37416	10313 45100
9209 75536	9767 03263	10343 40266
9227 07577	9769 51126	10369 21740
9241 25121	9781 34012	10399 12436
9257 62553	9787 21740	10453 62061
9277 02036	9839 12364	10463 52513
9281 62622	9857 23533	10477 67452
9319 62503	9871 32316	10487 05675
9377 66277	9887 33416	10501 77772
9413 17541	9901 15526	10531 35724
9433 25035	9907 01401	10597 42547
9437 43446	9929 44612	10639 70051

p	residue	p	residue	p	residue
10667	55573	11251	02106	11801	41730
10709	21742	11257	17745	11807	64000
10711	33125	11261	21260	11821	64453
10723	26405	11279	40455	11839	25215
10729	55703	11351	22147	11867	70645
10771	50555	11369	27670	11887	10035
10781	00164	11383	17361	11897	42220
10789	27651	11393	01511	11927	14155
10831	42672	11411	74045	11933	25571
10909	63265	11423	03630	11941	23743
10937	47503	11443	65257	11987	33200
10939	63332	11447	51354	12043	05651
10957	64103	11467	55443	12071	40741
11003	37656	11483	03450	12097	51143
11027	10024	11489	57555	12109	20110
11057	60335	11549	76107	12143	27361
11069	64651	11551	47006		
11093	03231	11593	12504		
11113	24506	11597	07213		
11117	57045	11657	53703		
11131	50752	11681	13417		
11159	12377	11689	23607		
11161	50166	11717	06015		
11177	45677	11743	76351		
11213	-	11779	14053		
11239	44172	11789	71203		

Table VI: Factors of M_p, $5000 < p < 17{,}000$

P	factors
5003	10007.1050631
5009	36425449
5011	80177
5021	40169
5023	
5039	10079
5051	10103
5059	179331433
5077	
5081	
5087	40697.1678711
5099	
5101	8110591
5107	51071
5113	
5119	82978991
5147	4185169817
5153	
5167	6531089.131696497
5171	10343
5179	248593.998770151
5189	155671.3362473
5197	31183.20195543
5209	1945613591
5227	1129033.47126633
5231	10463.41849.470791
5233	994271
5237	4022017
5261	42089
5273	38134337
5279	10559
5281	24715081
5297	4449481.45566266567
5303	10607.6024209.33737687
5309	
5323	2372950817
5333	
5347	310127
5351	
5381	48170713
5387	35028913631
5393	32359
5399	10799.5272458239
5407	
5413	5326393
5417	433361.3196031.200515673
5419	
5431	54311.1401199.6040879577
5437	2087809
5441	3656353
5443	
5449	2517439
5471	
5477	
5479	
5483	888247
5501	693127
5503	
5507	21675553
5519	662281
5521	88337.3533441
5527	
5531	940271.14639904343
5557	33343
5563	534049.623057
5569	37813511
5573	
5581	
5591	52462455217
5623	1135847.1324014073
5639	11279.2447327
5641	49748069257
5647	
5651	2828212481.3346929073
5653	
5657	218122607
5659	867830287
5669	
5683	875183.2436643081
5689	
5693	
5701	
5711	11423
5717	34303.45737
5737	
5741	48224401
5743	643217.13432968889
5749	
5779	924641
5783	
5791	926561
5801	34807.200204113
5807	139369
5813	
5821	88805177
5827	91658711
5839	
5843	712847.3069690167
5849	4105999
5851	
5857	
5861	46889
5867	16239857
5869	
5879	
5881	662671081
5897	
5903	11807.15489473.42182839.238433977

P	factors
5923	
5927	198969391
5939	617657.706741001
5953	
5981	3883379567
5987	60583758167
6007	
6011	288529
6029	84407.249359441
6037	
6043	
6047	
6053	
6067	206279.3118439.677222809
6073	
6079	
6089	52969672361
6091	
6101	7906897.807711391
6113	2530783
6121	81237913
6131	12263
6133	
6143	884593
6151	
6163	591649
6173	37039
6197	297457
6199	61991.743881
6203	148873
6211	
6217	
6221	
6229	
6247	
6257	
6263	12527
6269	
6271	13959247
6277	37663.1163404289
6287	5029601.5180489.57186553
6299	
6301	150959359
6311	3647759.68423863.1958694583
6317	694871.4548241
6323	12647
6329	
6337	
6343	9045119
6353	38119.2172727
6359	
6361	
6367	63671
6373	38239.140207.207849023.590432959

P	factors
6379	4972928063
6389	191671
6397	1944689
6421	5689007
6427	10951609.3959918927.52235468209
6449	51593
6451	
6469	
6473	2796337
6481	622177.2799793.38678609
6491	12983.69440719.12296978807
6521	4890751
6529	731249.1201337
6547	
6551	13103
6553	1454767.10286532433
6563	13127.26777041.179209279.34128597577
6569	6621553
6571	
6577	
6581	
6599	
6607	8034113.26285724863
6619	471762607
6637	5203409
6653	4305755071
6659	
6661	33930121529
6673	6766423.19551502967
6679	
6689	142168007
6691	321169
6701	
6703	442399
6709	
6719	1290049
6733	
6737	741071.1106754361
6761	26340857
6763	
6779	35331931073
6781	108497
6791	
6793	13261715767
6803	217697
6823	
6827	108958921
6829	8286786631
6833	
6841	41047.64962137.77973719
6857	
6863	1608865639
6869	257051719
6871	288583.39027281

P	factors
6883	1885943
6899	13799
6907	60312932423
6911	
6917	55337
6947	180623.333457
6949	6879511
6959	55673
6961	584208887
6967	1072919.448730537
6971	
6977	41863.209311.389414279
6983	13967.13630817
6991	
6997	2169071.3572164417.67983747617
7001	39107810033
7013	54547899457
7019	990366863
7027	373119647
7039	1252943.1057032553.8541573097
7043	14087
7057	621017
7069	
7079	14159.56633.1486591
7103	14207
7109	
7121	
7127	
7129	1867799
7151	14303
7159	26058761
7177	
7187	48871601
7193	5409137
7207	172969
7211	14423.57689.475927
7213	
7219	164362193
7229	
7237	
7243	
7247	
7253	52613263
7283	102267887
7297	1868033
7307	42715085233
7309	
7321	
7331	
7333	
7349	42197959
7351	
7369	
7393	6525239233

P	factors
7411	1022719.133709263.153496633
7417	118673.16269026327
7433	
7451	95506919
7457	19969847.7785883529.16694955311
7459	134263
7477	
7481	
7487	179689
7489	
7499	99121783
7507	
7517	12012167.27743142241
7523	
7529	105407.209170679
7537	723553
7541	9711963409
7547	16980751
7549	7460767289
7559	
7561	589759
7573	45439
7577	
7583	5889276287
7589	288383
7591	1897751
7603	
7607	
7621	
7639	550009.1840097599
7643	15287
7649	
7669	131093887.40807239817
7673	184153.13918823
7681	3994121
7687	445847
7691	15383.23104702303
7699	
7703	
7717	19446841.13968927551.57756173327
7723	
7727	
7741	8964079
7753	
7757	
7759	139663
7789	872369
7793	
7817	
7823	15647
7829	39555975527
7841	2367983.6837353
7853	47119.255002617
7867	

P	factors
7873	1180951.1200160121
7877	517471639
7879	259250617
7883	15767.441449
7901	47407.442457.679487
7907	546405329
7919	63353
7927	
7933	46405939823
7937	
7949	
7951	498813937
7963	152889601
7993	2066542193
8009	
8011	80111
8017	128273.585930463
8039	968554799.11908411871
8053	219927431
8059	7043567
8069	
8081	3498814409.36263568311.56994371767
8087	96671999.360437591
8089	
8093	29811811823
8101	712889
8111	16223.41917649.25919771153
8117	
8123	25798649
8147	
8161	6708343
8167	3136129.76835137
8171	800759.9412993.1089700903
8179	4318513
8191	
8209	14759783
8219	1988999
8221	920753.9667897.18480809
8231	214007.14329002199
8233	
8237	1054337
8243	16487.4207243687
8263	
8269	727673.19630607
8273	1042399.28062017.62014409
8287	36877151
8291	
8293	199033.6874946759
8297	
8311	
8317	382583
8329	
8353	50119.154146263.297834569
8363	

P	factors
8369	
8377	50263.134033.787439.2596871
8387	9276023
8389	
8419	488303.4188149417
8423	353767
8429	67433.455167.927191
8431	809377
8443	
8447	
8461	1404527
8467	203209.6655063.5910592559
8501	680081.221842097
8513	272417
8521	
8527	
8537	147843767
8539	13662401.10089972727
8543	
8563	32402393
8573	12345121.12254091887.21973130527
8581	
8597	481433
8599	85991
8609	
8623	80504329
8627	123348847
8629	258871
8641	46880604889
8647	
8663	17327
8669	2618039.1337175913
8677	118753423
8681	
8689	1008827657.1639075583
8693	260791
8699	417553.43790767
8707	
8713	1603193
8719	2877271
8731	2514529
8737	681487.6640121
8741	69929.5926399
8747	21021997487
8753	
8761	192743
8779	57336421553
8783	228359.46912673033
8803	2834567.226906129.7563748873
8807	228983
8819	
8821	405767
8831	
8837	

P	factors
8839	6523183
8849	52368383
8861	
8863	
8867	70937.9284174617
8887	
8893	
8923	
8929	196439
8933	36232249.1478072047
8941	
8951	17903
8963	663263
8969	13345873.1142273903
8971	59568301217
8999	
9001	1512169
9007	90071
9011	
9013	
9029	722321.25913231.455621399
9041	
9043	37268518009
9049	28721527.28938703
9059	18119.30293297
9067	21497004703
9091	
9103	2454405479
9109	4955297.49625833
9127	146033.8707159
9133	
9137	1005071.2704553
9151	
9157	3076753
9161	86901247.12187849367
9173	495343
9181	1377151
9187	
9199	53354201
9203	
9209	
9221	719239.91841161.168025063.5660569039
9227	
9239	800633263
9241	
9257	
9277	
9281	
9283	5941121.29352847.34031479.41532143
9293	4598548121
9311	1415273
9319	
9323	895009
9337	2614361.2838449
9341	74729
9343	149489
9349	1793044711
9371	18743.7281660583
9377	
9391	93911
9397	225529.2405633
9403	2576423.5735831
9413	
9419	18839
9421	8573111
9431	679033
9433	
9437	
9439	273523343
9461	75689
9463	
9467	1340299993.4104001303
9473	
9479	18959.48532481
9491	531497
9497	531833
9511	95111
9521	361799
9533	
9539	19079
9547	631801367
9551	
9587	
9601	2285039.3513967.16974569
9613	57679.146559799.2253979337
9619	615617.17256487.53840698033
9623	
9629	27152451199
9631	
9643	12362327
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9661	
9677	607618831
9679	
9689	
9697	
9719	
9721	
9733	2932747561
9739	263751599
9743	34626623.564723767
9749	
9767	

P	factors
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9781	
9787	
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9803	63388001753
9811	7770313
9817	20556799.26619050743
9829	707689.14075129
9833	4562513
9839	
9851	78809.3723679
9857	
9859	1104209.1656313
9871	
9883	158129.10436449.21258273703
9887	
9901	
9907	
9923	2182682927.8488689889
9929	
9931	
9941	
9949	8098487
9967	
9973	299191.7419913.10591327.19367567
10007	240169.60282169.136255313
10009	35311753
10037	
10039	45613381103
10061	
10067	503351.34439287537
10069	
10079	
10091	20183.484369
10093	306665713
10099	
10103	2804693831
10111	101111
10133	141863
10139	1216681.4075879
10141	162257.136599271
10151	1948993.62820641017
10159	
10163	20327
10169	
10177	
10181	488689
10193	69720121
10211	81689.735193
10223	1846703167
10243	18847121
10247	184447.246419857
10253	1293682529
10259	

P	factors
10267	35491478951
10271	20543
10273	
10289	246937
10301	4532441
10303	
10313	
10321	61927
10331	20663.268607.4049753
10333	1239961
10337	163076513
10343	
10357	62143
10369	
10391	19389607
10399	
10427	35037410167
10429	5569087
10433	146063
10453	
10457	62743.313711.31794194791
10459	11632186031
10463	
10477	
10487	
10499	14028847793
10501	
10513	252313.508471759
10529	60962911.37429900087
10531	
10559	193546471
10567	464292847
10589	2033089
10597	
10601	3980103047
10607	275783
10613	339617
10627	10755119113
10631	531551.31946920433
10639	
10651	73981847
10657	2216657.39041962129
10663	170609
10667	
10687	7096169
10691	21383.10200069281.11345203673
10709	
10711	
10723	
10729	
10733	64399.310226633.465812201
10739	3810390503
10753	172049
10771	

P	factors
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10789	
10799	21599.1024263553
10831	
10837	1798943.4115610839
10847	71590201
10853	65119
10859	542951
10861	1477097
10867	260809
10883	21767.7574569.22123941871
10889	7584754729
10891	196039
10903	40668191
10909	
10937	
10939	
10949	153287.1472136847
10957	
10973	65839.153623.18434641
10979	87833.270610393
10987	197767
10993	241847
11003	
11027	
11047	13433153.355116863.2911370569
11057	
11059	464479
11069	
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